Öko-Institut e.V.
Institut für angewandte Ökologie
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Adaption to scientific and technical progress under Directive 2002/95/EC

Results previous evaluation

Exemption No. 7 c

"a) Lead in high melting temperature type solders (i.e. lead-based alloys containing 85 % by weight or more lead)

b) lead in solders for servers, storage and storage array systems, network infrastructure equipment for switching, signalling, transmission as well as network management for telecommunications

c) lead in electronic ceramic parts (e.g. piezoelectronic devices)"

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thin wires are possible, however, at the cost of lower energy efficiency of the power transformers. The lead emissions linked to the additional energy consumption are in the same order of magnitude like the amount of lead in the respective solder joints in the power transformers. The additional lead emissions into the environment would at least partially compensate the lead avoided in the power transformers. The exemption would thus be in line with the requirements of article 5 (1) (b).

The wording of the exemption should be:

Lead in solders for the soldering of thin copper wires of 100 µm diameter and less in power transformers

5.1.5 References

[1] Frischknecht R., Faist Emmenegger M. (2003): Strommix und Stromnetz. In: Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz (Ed. Dones R.). Final report ecoinvent 2000 No. 6, Paul Scherrer Institut

[2] Villigen, Swiss Centre for Life Cycle Inventories, Duebendorf, CH, Online-Version under: www.ecoinvent.ch.

5.2 Lead in trimmer potentiometer elements (set 6, request no. 22, Tokyo Denshi)

Explanations of specific terms:

Cermet — Heat resistant material made of ceramic and sintered metal; here the resistive layer and the ceramic body on which it is sintered upon.

5.2.1 Description of requested exemption

Trimmer potentiometers are variable resistors. They work with a wiper to adjust the resistance of the circuit. They are applied in a wide range of products like e.g. audio-visual equipment, communication equipment, toys and measuring devices, electrical household appliances.

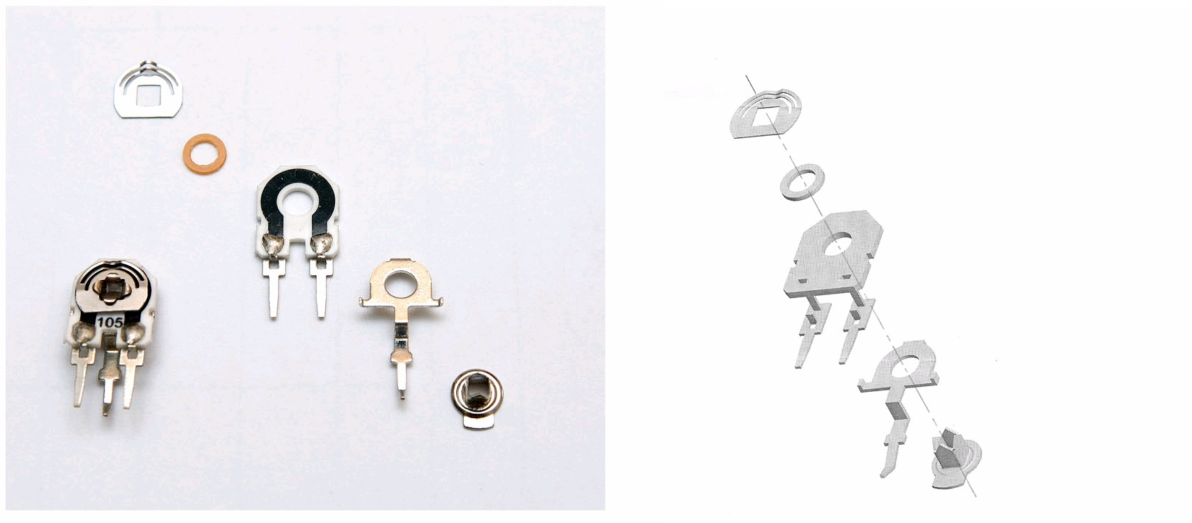

Figure 3: Example of a trimmer potentiometer (source: Tokyo Denshi)

The trimmer potentiometer elements contain lead as lead oxide in resistive inks. The resistive ink is composed of silver, lead-ruthenium-oxide and boron trioxide. The applicant says that currently there is no viable lead-free thickfilm paste available on the market.

Trimmer potentiometer elements weigh between 0.048 g to 0.106 g, with a lead oxide content of 0.108 % to 0.35 % corresponding to around 0.052 mg to 0.3 mg of lead oxide per trimmer potentiometer. The applicant sells around 54,000,000 pieces of cermet potentiometers. The total amount of lead oxide in the applicant's products thus is between around three to 16 kg per year. Tokyo Denshi Ltd. assumes that it is currently occupying 1 % of the entire cermet trimmer potentiometer market. The total global annual volume of would then be around 5,400 million of such trimmer potentiometers resulting in around 1,600 kg of lead oxide (PbO) or 1,500 kg of lead consumed in this context.

As cermet trimmer potentiometers come in many different sizes and shapes and there are millions of manufacturers in the entire industry, it would be difficult to give any accurate figure to the annual volume and thus the amount of lead oxide used in this scope. Yet, we can still give a rough estimate based on our annual output and market share. Assuming that Tokyo Denshi Ltd. is currently occupying 1% of the entire cermet trimmer potentiometer market, our annual output of 54 million pcs. (and 16.2 kgs. of lead oxide consumed) projects a global annual volume of 5,400 million pcs. and thus 1,620 kgs. of lead oxide consumed in this context. We hope this rough estimate may help you address the possible amount of hazard that could bring about.

The applicant suggests the following wording for the exemption:

Lead in thickfilm pastes for the manufacturing of cermet-based trimmer potentiometer elements

5.2.2 Justification for exemption as submitted by applicant and stakeholders

The resistive ink is applied as a thickfilm paste, which is printed on the cermet base as a conductive agent between the wiper and the terminals. After printing, the thickfilm paste is sintered onto the cermet base. The lead-oxide in the conductive ink is necessary to evenly melt the ruthenium-oxide and bond it on the cermet base. Its low sintering temperature below 500 °C lowers the curing temperature of the ruthenium-oxide solvent, which enables bonding the ruthenium oxide to the cermet base without cracking it. Further on, the lead-oxide works as a bonding agent connecting the aluminium-oxide based cermet and the conductive film of lead-ruthenium oxide. The lead-oxide enhances the adherence of the ruthenium-oxide/ruthenium-dioxide to the cermet base ensuring proper conductivity and the functionality of the trimmer potentiometer. Compared to other thickfilm resistors, the resistive layer in trimmer potentiometers must have a higher mechanical stability. The wiper runs over the resistor to adjust the resistance, which will cause abrasion of the resistive layer over time if the layer does not have sufficient mechanical stability against abrasion. The applicant says that on cermets, there is no technically viable substitute to replace the lead-oxide as bonding agent in the thickfilm pastes for the resistive ink.

There is another type of trimmer potentiometers, which are bakelite-based. They can be manufactured RoHS-compliantly without lead, but are not appropriate for all applications. Firing RuO2 materials on a bakelite film is impossible owing to the high curing temperature. In this connection, only Pb-free carbon can be printed as the resistive track of a bakelite-based potentiometer. This carbon, according to the applicant, is too sensitive to temperature and humidity changes. The bakelite potentiometers thus can function properly at working temperatures of not more than 40°C, while that of a cermet potentiometer can operate at temperatures as high as 70°C or even more.

The applicant states that another important criterion is concerning the working power rating. A cermet (RuO2 resistive track) trimmer potentiometer can withstand power ratings as high as 0.3 W to 0.5 W. A bakelite trimmer potentiometer with carbon track would burn down at such power ratings and hence the device circuit went out of order. In this connection, it is thus not uncommon to see that devices including automobile audio/visual equipment, automobile ABS systems, telecom equipment, heaters, negative ion hair clippers, etc. are all using cermet based (RuO2 resistive track) trimmer potentiometers.

As the consumer market is producing products with more compact sizes, the use of smaller surface-mounted trimmer potentiometers is prevailing. Yet, as the working power rating of bakelite base trimmer potentiometer would drop in proportion to its size, they cannot provide a solution to the power rating requirement of these device circuits. In contrary, the cermet based trimmer potentiometers with the RuO2 resistive tracks can provide the necessary power ratings even in surface mounted, meaning miniaturised versions, according to the applicant. The applicant states that all surface mount trimmer potentiometers are of cermet base and RuO2 track. Matsushita, Kyocera, Murata, Bourns, etc. trimmer potentiometer manufacturers are all designing the surface-mounted trimmer potentiometers in cermet base and RuO2 resistive track.

5.2.3 Critical review of information as submitted by applicant and stakeholders

Electrolux had submitted a stakeholder document opposing the applicant's exemption request. Electrolux confirms that it uses fully RoHS compliant trimmer potentiometers in its products (see attached stakeholder document "Trimmer_potentiometer_stakeholder.pdf"). The consultation of both the applicant and of Electrolux cleared the situation. It showed that the stakeholder had understood the applicant's exemption request as a request for a general exemption for lead in trimmer potentiometers. The title of the exemption request in the stakeholder consultation round no. 6 was "Lead in trimmer potentiometers". The exemption request, however, is limited to the use of lead in cermet-based trimmer potentiometers.

After further investigations at a thickfilm paste manufacturer and manufacturers of trimmer potentiometers, the applicant's information could be confirmed. Bakelite-based trimmer potentiometers are not appropriate for higher power rates and higher moisture. Lead-free thickfilm pastes are not available currently for the use in cermet-based trimmer potentiometers.

Although for some ranges of resistance, lead-free pastes are possibly available, the mechanical resistance against abrasion is not yet high enough to allow a reliable product.

The respective industries so far considered the following exemptions to cover the use of such lead-containing thickfilm pastes in trimmer potentiometers:

- No. 5: lead in glass of cathode ray tubes, electronic components and fluorescent tubes, and
- No. 7: lead in electronic ceramic parts (e.g. piezoelectronic devices).

The applicant was asked whether he was aware of this situation. He replied that he had checked the RoHS Directive about this matter before he submitted his proposal. The applicant says that it is the ruthenium oxide (RuO2) resistive film printed on the ceramic sheet that contains lead. Tokyo Denshi had consulted a test laboratory technician about the exemption status. The technician replied that he would not agree with the compliance of the resistive film.

The applicant had sought a formal explanation from EU about the inclusion of leaded potentiometer elements in these exemptions, but the Commission did not take a position. Tokyo Denshi therefore believed that a formal exemption request would be the best to ease the queries in the global electronics market.

The sintering process will not change the chemical form of lead-oxide into another chemical form. The applicant as well as another manufacturer of thickfilm pastes and vendor of cermet-based trimmer potentiometers confirmed that *the resistive layer is made up of lead ruthenium oxide and lead oxide, which is by nature not a glass. Tokyo Denshi states that it is electrically conductive and the lead oxide added is to serve as an epoxy or bonding agent to get the resistive layer sintered on the ceramic base at high temperature. According to the applicant, after sintering the resistive track can be removed by grinding or lapping. Lead oxide itself stays on the cermet base surface but does not penetrate into the cermet body. The lead ruthenium oxide (i.e. the resistive layer) could not be classified as any glass component, although glass may contain lead also. Lead oxide added to enable the sintering may be similar to glass.*

A further manufacturer of thickfilm pastes and trimmer potentiometers confirmed that lead is available as lead-ruthenium-oxide and that the lead is an essential for the resistivity properties of the cermet material (document “technical fiche20000901.pdf”). He added that lead also is contained in the glass as lead-boron-silicate and as such is a constituent of the glass components in the cermet layer. The proportionate distribution of lead between the lead in glass and the lead in the resistive layer itself is not known. The stakeholder as well as the applicant confirms that the resistive layer in principle can be mechanically disjointed by grinding from the ceramic body and hence consider it as a homogeneous material.

According to the stakeholder, the thickfilm paste contains around 15 % to 20 % of lead in $Pb_2Ru_2O_7$ (lead-ruthenium-oxide, see document “technical fiche20000901.pdf”). Assuming that the thickfilm paste does not considerably loose weight during the sintering process, this corresponds to a lead content of around 8.5 % to 11.4 % in the resistive layer, which is clearly above the maximum threshold of 0.1 % for a RoHS-compliant homogeneous material.

Exemption no. 7 for lead in ceramic parts can be ruled out as both the applicant as all stakeholders involved classify the non-conductive part of the resistive layer or parts thereof as glass, not as ceramic.

In order to be covered by the above exemptions listed in the RoHS Directive, the thickfilm paste <u>after</u> application, in the finished trimmer potentiometer, would have to be categorized under one of the following categories:

1. The resistive layer itself is classified as a glass after the sintering process. It would then be lead in glass of an electronic component and exemption no. 5 would apply. The applicant had ruled out this possibility.
2. The stakeholder classified the resistive layer (excluding the ceramic base) as a homogeneous material. The stakeholder says that in the sintering process, the lead in the lead-ruthenium-oxide and the glasses become inseparably connected in the resistive layer. He proposes that the lead in the lead-ruthenium-oxide could be considered as a glass, although the homogeneous material itself is not a glass. Exemption no. 5 would then apply.

   It is not clear, whether this is a viable interpretation of exemption no. 5. The interpretation of the RoHS Directive is beyond the contractor's competence. The contractors' leave the decision to the respective European entities whether this interpretation is permissible.

A new exemption would be justified in line with article 5 (1) (b) of the RoHS Directive if this application is not considered to fall under exemption no. 5

5.2.4 Final recommendation

It is recommended to grant this exemption if this use of lead is not considered to fall und exemption no. 5 allowing the use of lead in glasses of electronic components as laid out in the previous paragraph under number 2 in section 5.2.3.

The wording of the exemption would be:

Lead in cermet-based trimmer potentiometer elements

5.3 "Cadmium in optoelectronic components" (set 6, request no. 23, Marshall Amplification plc), and "3 year grace period on the use of Cadmium-based photoresistors used in professional audio equipment, for the purpose of investigating suitable alternatives and redesigning audio products accordingly" (set 7, request no. 4, Sound Devices)

Marshall Amplification had already requested this exemption in a previous stakeholder round (4th stakeholder consultation, request no. 5). A final recommendation was not pronounced at that time (see final report from July 2006, http://ec.europa.eu/environment/waste/weee/pdf/rohs_report.pdf). Marshall therefore has submitted an almost identical request again in the sixth stakeholder consultation.

Sound Devices submitted an exemption request in the seventh stakeholder consultation, which refers to the use of cadmium in optocouplers in professional audio equipment as well. Both exemption requests target an identical exemption for identical or very similar applications in the audio industry. Hence, they are reviewed together in the following.

5.3.1 Special terms and definitions

Audio limiter	A device that permits a high compression to be applied above a set threshold. It limits the output level from rising much above the set threshold. Vice versa, it facilitates the maximization of an audio signal to the upper limits of the capabilities of the audio circuitry. Audio limiters prevent overload distortion, or "clipping". Further on, it allows for maximization of the audio level of the desirable audio signal relative to the audio noise in the floor of the audio signal, an inherent artefact to audio circuitry. (Source: Sound Devices)